AN INVENTORY OF THE BUTTERFLY SPECIES (LEPIDOPTERA: RHOPALOCERA) OF THE UPPER IMBANG-CALIBAN WATERSHED, NORTH NEGROS FOREST RESERVE, PHILIPPINES

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ABSTRACT

Coral Cay Conservation (CCC) recently completed an inventory survey of the butterfly fauna of the Upper Imbang-Caliban watershed area of the North Negros Forest Reserve (NNFR), Negros Occidental, Philippines. The NNFR is one of the last significant areas of moist tropical forest in the Negros-Panay Faunal Region of the Philippines and therefore is considered to be vital for the conservation of a high number of forest-dependent and endemic species. The inventory results revealed that 45% of all species and 84% of sub-species recorded were Philippine endemics, with 21% of sub-species recorded occurring only on Negros. This is the first published account of the butterfly species in the NNFR and highlights the relative importance of the NNFR for the conservation of endemic and restricted-range butterfly species and the need for long-term conservation management of the remaining forest area. Suggestions for conservation and sustainable management of the butterfly fauna of the NNFR are discussed.

Introduction

The Philippines is one of the richest and most distinct biogeographical regions of the world. It has an extraordinarily high percentage of endemicity, with over two-thirds of its plant and animal species being found nowhere else in the world (Oliver & Heaney, 1996). In excess of 57% of the terrestrial vertebrate fauna is unique to the Philippines (Oliver & Heaney, 1996) and with regard to invertebrates approximately 40% of its butterfly species are also found only in the Philippines (Baltazar, 1991;

Treadaway, 1995). The Philippines has much higher levels of endemicity than any other biogeographic province in the whole of the Indo-Malayan Realm - itself one of the richest and most distinct biogeographic regions in the world (MacKinnon & MacKinnon, 1986). However, only 25% of endangered or critically endangered butterflies are thought to have a population in the existing protected areas of the Philippines, compared to 67% of terrestrial mammal species (Danielsen & Treadaway, 2004).

Thirty percent of the world's highest priority areas for conservation are in the central Philippines (Oliver & Heaney, 1996). However, the 14 existing terrestrial Priority Sites in the Philippines only cover 2.7% of the land area (Danielsen & Treadaway, 2004). The forest fragments of the central Philippine islands, including Panay, Guimaras, Negros, Cebu, Sibuyan, and Masbate, which make up the islands of the Visayas (Figure 1), form a distinct faunistic region. These islands also fall into the International Union for the Conservation of Nature (IUCN) category of the highest conservation priority (Dinerstein *et al.*, 1995), and have been identified as centers of plant biodiversity (Davis, 1995). Cebu, Masbate, and Guimaras have been completely deforested, and most of their native and endemic species of flora and fauna are now extinct, 'functionally extinct', or critically threatened (Oliver & Heaney, 1996). However, small forest fragments still exist on Panay and Negros, which together make one of the largest faunal regions in the area, the Negros-Panay Faunal Region. Thus, it seems crucial that these remaining forest fragments be preserved and studied.

The North Negros Forest Reserve (NNFR) is one of the last remaining wet tropical rainforest ecosystems of the Negros-Panay Faunal Region and is an important refuge for a large number of endemic species (Hamann *et al.*, 1999). In 1875, 95% of NNFR was primary rainforest; while the official figures calculated it to be 7% in 1996 (Diestel, undated, unpublished report), it is estimated that less than 3% actually remains (Gerardo Ledesma (NFEFI), pers. comm.). Originally established in 1946 to protect

more than 100,000 ha of virgin forest, the NNFR is now reduced to 80,500 ha. Yet, protection of the reserve is largely ignored (Hamann *et al.*, 1996, unpublished) and virtually all of the lowland dipterocarp forest has been illegally cleared. However, the steep topography of the higher slopes has protected them from extensive logging. Thus, two major fragments of old growth forest exist in half-craters of extinct volcanoes, Mt. Mandalagan and Mt. Silay, and form, together with the Mt. Canlaon area, the last intact watershed of Negros Occidental (Figure 1) (Hamann *et al.*, 1996, unpublished). A commonly identified threat, especially to tropical butterfly faunas, is collection and trade in species. This does not appear to be a problem in the NNFR, and no collectors were encountered. However, dead specimens of Philippine butterflies, including species found in the NNFR, were seen for sale in the nearby city of Bacolod. Hunting, non-timber resource extraction, and clearance of the forest for agriculture are however still common problems in the NNFR (Turner, Slade, & Hesse, 2002, unpublished), and action is desperately needed to protect this unique rainforest fragment.

While several butterfly studies have been carried out in South East Asia (Hill *et al.*, 1992; Spitzer *et al.*, 1993; Hamer *et al.*, 1997; Hill & Hamer, 1998), a literature review of major scientific peer-reviewed journals found no accessibly published research into the ecology of the butterflies of the Philippines. In particular, the butterflies in the North Negros Forest Reserve have never been studied. Although an inventory of Philippine butterflies (Baltazar, 1991) is available, this only gives taxonomic information and known geographical distributions to date but does not contain descriptions or illustrations. More recently, a more comprehensive checklist of the butterflies of the Philippines, which also includes photographs of many of the species (Treadaway, 1995) and checklists focusing on specific groups, has been published (Page & Treadaway, 2003). However, as this checklist is not published in the major scientific literature or in a Philippine journal, it is not widely available.

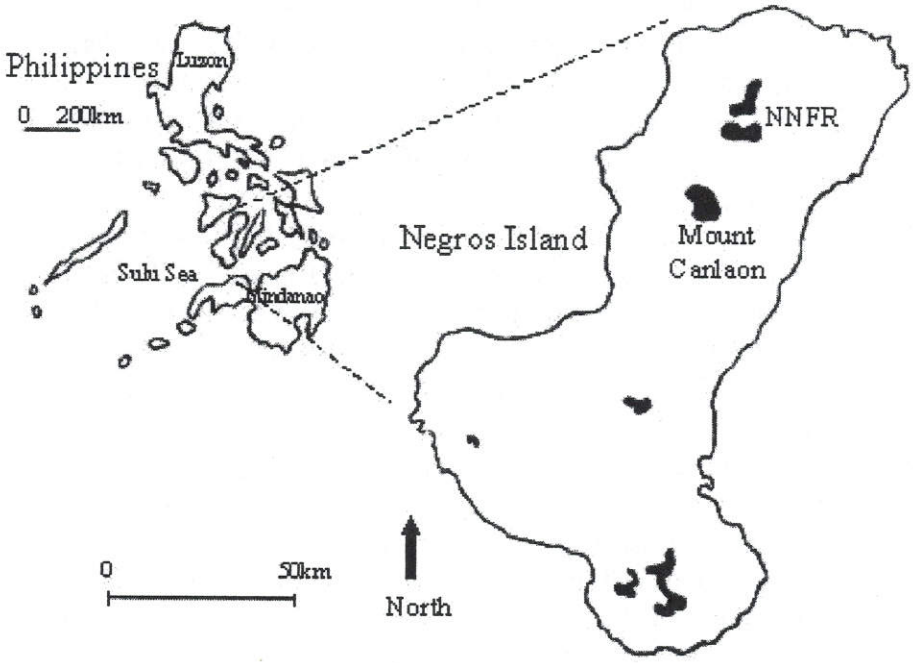


Figure 1. The remaining forest patches of Negros Island and the location of the North Negros Forest Reserve (NNFR) within Negros Island, Philippines.

Thus, it is hoped that publishing our inventory in a local Philippine journal will make it accessible to local biologists. As butterflies of some areas of the Philippines have still not been studied comprehensively, it is expected that new species and sub-species will continue to be discovered. Since 1990, 38 endemic species and 212 endemic subspecies have been described (Danielsen & Treadaway, 2004). Moreover, as the forests of the Philippines continue to decline, the distributions and occurrance of butterflies will continue to change. A revised checklist of Philippine butterflies will be published in 2004 (Treadaway, pers. comm.). At the current time 29 butterfly taxa in the Philippines are under risk of extinction in the near

future, and of these only five are thought to occur in an established conservation site (Danielsen & Treadaway, 2004). Lastly, all previous records of the species and sub-species found on Negros are for Southern Negros and the other northern forest fragment, Mount Canlaon National Park (Baltazar, 1991). The NNFR could therefore act as a good back up to the Mount Canlaon National Park as the two areas are only 35 km apart. Thus, this represents the first inventory of butterflies in the NNFR forest remnant, and is published in complement with a photographic field guide of the butterflies of the NNFR (Slade, Cummings, & Turner, 2002).

Inventories of Philippine butterflies (Baltazar, 1991; Treadaway, 1995) have already noted the high endemicity (~ 40%) of Philippine butterflies. However, current knowledge is still incomplete and with forest cover in the Philippines declining from 70% to 18% cover in the last 100 years (ESSC, 1999; DENR/UNEP, 1997), it is of paramount importance that inventories of both butterflies and other invertebrates continue to be undertaken so that species can be catalogued and informed conservation measures and further research can be carried out to protect those endemic or restricted-range species. Moreover, insects, in particular butterflies, respond rapidly to forest disturbance, and thus may be useful in assessing how forest disturbance affects biodiversity (Hill & Hamer, 1998; Kremen, 1992). Tropical butterfly assemblages are particularly diverse, with many sites having large numbers of endemic species, most of which are dependent to some extent on forest habitat (Sutton & Collins, 1991). Butterflies are a suitable group for ecological studies; they are relatively conspicuous, mostly diurnal, their taxonomy is relatively well known, and some data on their geographic distributions and, for some species, on their life history, are available (Hill *et al.*, 1992; Beccaloni & Gaston, 1995; Spitzer *et al.*, 1993). Needless to stress, a detailed inventory

and photographic guide to the butterflies of the NNFR would greatly aid future ecological research and conservation decisions. Ultimately, butterflies may act as an 'umbrella' group for less easily studied invertebrate groups within the NNFR.

Aims and Objectives

The present study was undertaken as part of the Negros Rainforest Conservation Project (NRCP), a joint program of research, restoration, and education between the Negros Forests and Ecological Foundation, Inc. (NFEFI) and Coral Cay Conservation (CCC). The study set out to complete the first detailed species inventory of the butterfly fauna in a representative portion of the NNFR (the Upper Imbang-Caliban Watershed), surveying the major habitat types. The data presented form part of an inventory completed between February 2000 and July 2001. As no previous inventory work had been conducted within the NNFR, and data regarding other areas in Negros were scarce, there were no field guides in existence. Therefore, this study aimed to facilitate the development of a local field guide and to aid further habitat specific surveys. Consequently, this work does not intend to present a definitive list of the butterfly fauna of the NNFR, but attempts to outline the first representative inventory, of a specific catchment, that forms part of the wider conservation research being undertaken by the NRCP (Turner, Slade, & Ledesma 2001). The work was completed in collaboration with the NFEFI and under the aegis of the Philippine Department of the Environment and Natural Resources.

Study Area

The NNFR is an old forest reserve with extensive areas of old growth forest on the higher slopes of Mount Mandalagan and Mount Silay. Located 35 km to the North of Mount Canlaon on Negros Island, Philippines (Figure 1),

the area of the NNFR is 80,454ha, but only 16,687ha of forest remain (Collar *et al.* 1999). The old growth forest is predominantly above 1000m, with very little forest found below 800m. The inventory work was undertaken within four-hours trek of the village of Campuestohan (10° 39'N, 123° 08'E) on the southwest edge of the NNFR. The surveys were concentrated within the Municipalities of Talisay and Murcia, Province of Negros Occidental (see Mallari *et al.*, 2001; Turner, Slade, & Ledesma, 2002), which forms the Upper Imbang-Caliban Watershed.

Methods

Two methods were used to inventory the species richness of the NNFR: transect walks and opportunistic collections. Collections were made during wet and dry seasons and in six major habitat types represented in the NNFR (Table 1). The species inventory was compiled through collections made between June 2001-July 2002. The habitat types varied from cultivated land to old-growth and mossy forest and the forest habitats also varied in their degree of disturbance. Sites also varied in altitude from 700m-1600m.

The inventory was undertaken by CCC trained volunteers (Turner, Slade, & Ledesma, 2001) and were conducted along established transects; two transects in each site; each transect 500m in length. The use of transects meant that a wide variety of habitats and microclimates (streams, canopy gaps, different aspects, etc.) were surveyed (Hill, 1999). The transects had been established according to standard biodiversity assessment methods for tropical forests (see Alder & Synnott, 1992; Dallmeier, 1992; Turner, Slade, & Ledesma, 2001 for further details).

Table 1. Major habitat types within the NNFR in which surveys were undertaken (taken from Turner, Slade, & Hesse, 2002, unpublished).

Habitat	Code	Description	Altitudinal Range
Old-growth forest	OF	*Montane forest selectively logged for economic species 35 years ago.	1200-1400m
Secondary forest (intermediately disturbed)	SF	*Sub-montane forest legally logged for economic species, and illegally logged for other commercial species until 11 years ago.	1000-1200m
Secondary re-growth forest	RF	*Sub-montane forest legally logged for economic species, illegally logged for other commercial species, and cut for charcoal production resulting in complete exploitation until 11 years ago.	800-1000m
Mossy forest	M	*Montane forest above 1400m; not logged.	1400-1600m
Scrub/Grassland	SG	Land cleared of forest but not cultivated.	700-900m
Cultivated	CU	Land cleared for subsistence agriculture.	700-900m

*Classification according to Heaney (2001) and history derived from interviews with local community members.

In accordance with other studies (e.g. Hamer *et al.*, 1997; Spitzer *et al.*, 1993, 1997), the butterfly families Lycaenidae and Hesperiidae, which are difficult to identify and catch, were omitted from the inventory. Thus, only butterflies from the five families, Papilionidae, Nymphalidae, Pieridae, Satyridae, and Danaidae, were collected. As it was not the intention of this work to provide a definitive list of the butterfly fauna of the NNFR but to outline the first representative inventory, of a specific catchment, that could be used to identify a subset of the butterfly fauna that could be monitored (e.g. Sparrow *et al.*, 1994), and to identify endemic and endangered species in need of protection, it was thought to be sufficient to sample only the five most conspicuous families to begin with.

Peak butterfly density has been noted to occur from late morning to early afternoon (Hill *et al.*, 1995; Pollard, 1977; Pollard, 1988; Walpole & Sheldon, 1999). In accordance with other studies, transect walks were therefore only conducted between 10 00 hours and 15 00 hours, and only in good weather (i.e. sunny, and no rain), as temperature/irradiance differences are known to affect butterfly flight (Pollard & Yates, 1993; Willott *et al.*, 2000). Opportunistic collections were made while moving between survey sites or around the research base in Campuestohan.

Butterflies were caught using English kite nets and killed by pinching the thorax. It was found that killing agents, such as ammonia, tended to cause discoloration of the scales, and damage often occurred to the wings while the butterflies are in the killing jar. Pinning and preservation followed the guidelines set out in "A Lepidopterists Handbook" (Dickson, 1992). Only one type specimen, of each sex where possible, of each new 'species' encountered (within the target families) was collected and preserved where possible; any duplicates were released.

Each type specimen was given a code consisting of letters and numbers. This separated specimens into the five main families (Papilionidae (PA), Nymphalidae (N), Pieridae

(PI), Satyridae (S), and Danaidae (D)) which are relatively easy to distinguish on the basis of color and wing shape. Each specimen was then given a number (See Table 2). Photographs of the dorsal and ventral surface of each specimen were then taken. All butterflies were collected under a Wildlife Gratuitous Permit issued to NFEFI by the Department of the Environment and Natural Resources.

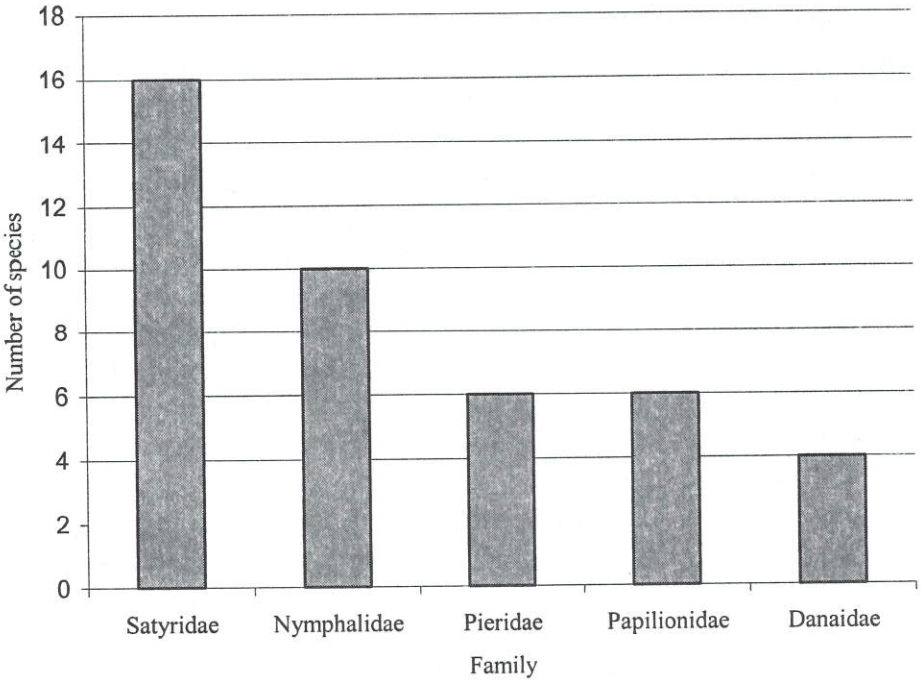
Butterfly species identification and taxonomic classifications followed that given by D'Abrera (1982, 1985, 1990) and Tsukada (1981, 1982*a*, 1982*b*, 1985, 1991). Sub-species were identified using Baltazar (1991), Treadaway (1995), and with the help of Dr. Jumalon of the Butterfly Sanctuary in Cebu, Philippines. The classification and geographical distribution of species and sub-species follow those given by the above authors (Table 2). The occurrence of butterflies is taken from Treadaway (1995) to give an idea of rarity. However, due to the limited work conducted on butterflies in the Philippines and the rapid loss of forested areas, knowledge of distributions and rarity, especially of sub-species, is constantly changing.

Results

Forty-two species from five families (Papilionidae, Nymphalidae, Pieridae, Satyridae, and Danaidae) were collected (Table 2). The Satyridae was the most speciose taxon, and the Danaidae the least (Fig. 2).

Using nested levels of endemism, there appears to be exceptionally high endemicity of both species and sub-species. Forty-five percent of species and 84% of sub-species collected are Philippine endemics. Ten percent of species and 50% of sub-species are endemic to the Negros-Panay faunal region, while a staggering 21% of sub-species are found only on Negros. However, no species found were endemic to Negros (Fig. 3 & Fig. 4).

Figure 2. Frequency distribution of butterfly species within families located in the NNFR.



Eighty-eight percent of the species were recorded in one of the four forest habitats. Of these, 62% rely entirely on forest, the remaining 26% being recorded in both forest and non-forest (i.e. scrub/grassland or cultivated) habitats, with only 12% of the butterflies found only in habitats outside the forest (Fig. 5). However, of these five species, two are species endemic to the Philippines, and four are sub-species that are Philippine endemics. Two of these sub-species (*Ragadia luzonia negrosensis* and *Atrophaneura semperi baglantis*) are Negros endemics, with the latter listed by Treadaway (1995) as rare (Table 2). Following Treadaway (1995), all species encountered in this study are listed as either common (57% of species) or uncommon/local (40% of species); except for *Atrophaneura semperi baglantis,* we did not find any species listed as rare or very rare.

Figure 3. Classification of species identified according to increasing nested levels of endemism.

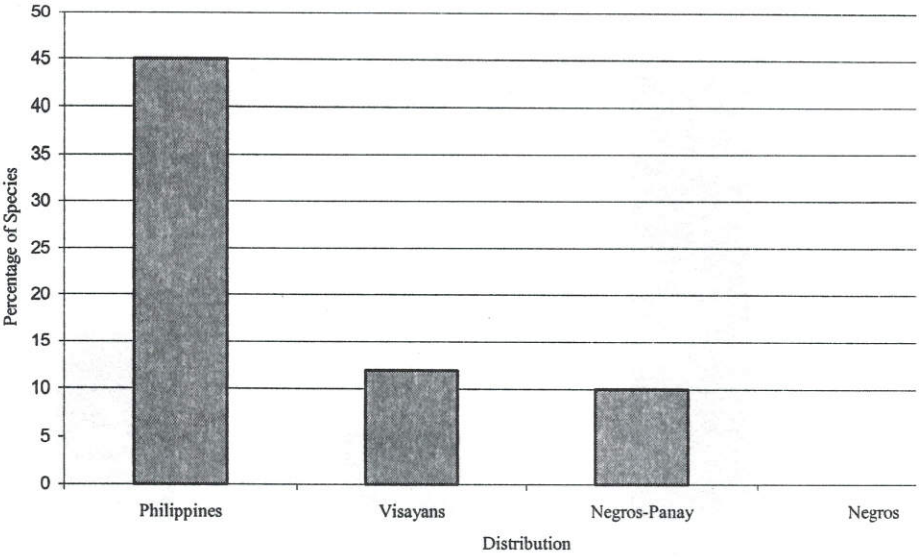


Figure 4. Classification of sub-species identified according to increasing nested levels of endemism

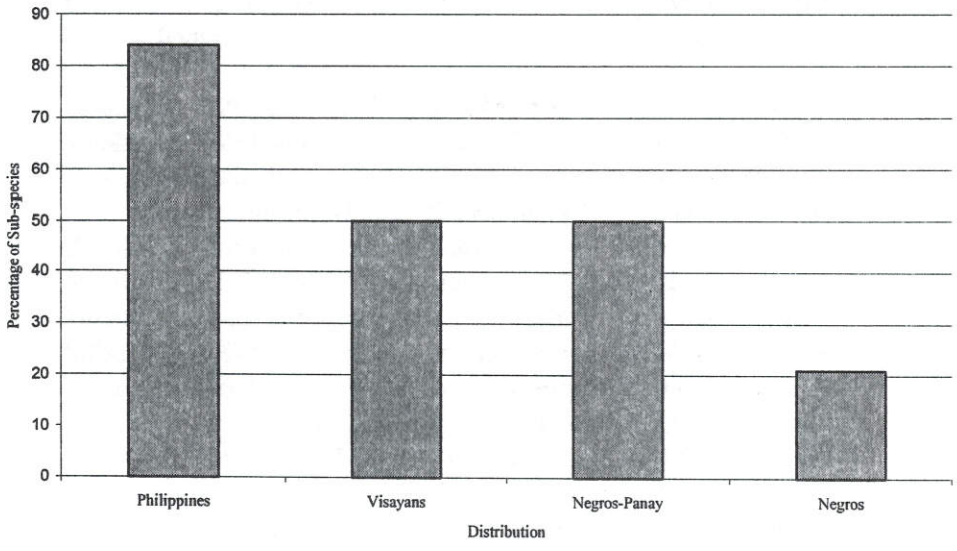


Figure 5. Habitat preferences of butterfly species recorded in the NNFR.

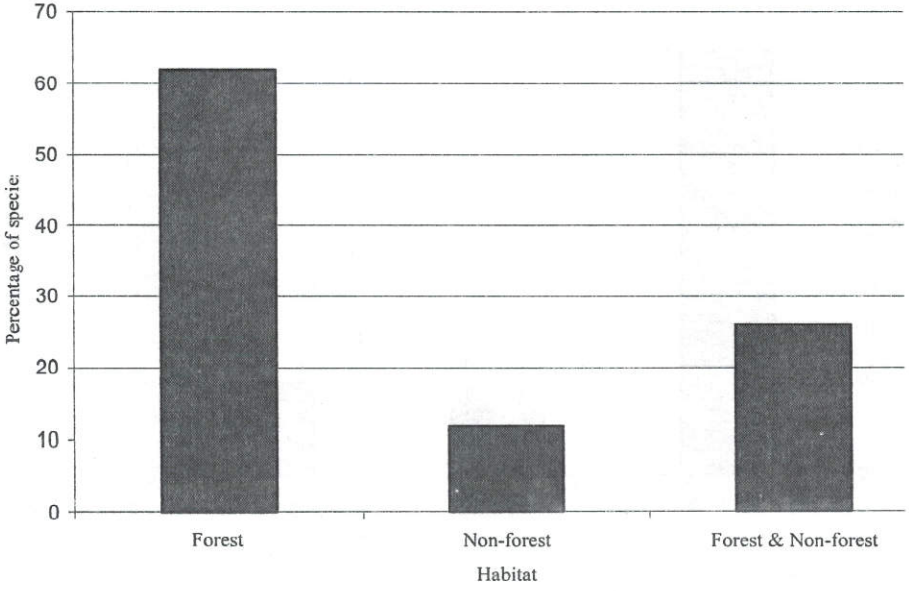


Table 2. (Next page) Butterfly species and sub-species recorded within the survey areas of the Imbang-Caliban watershed.

Classification and distribution based on: D'Abrera (1982); D'Abrera (1985); D'Abrera (1990); Tsukada & Nishiyama (1982); Tsukada (1981); Tsukada (1982); Tsukada (1985); Tsukada & Azumino (1991); Baltazar (1991) and Slade (2002). Occurrence based on Treadaway (1995): 1 = very rare; 2 = rare; 3 = uncommon or local; 4 = common. Habitat classification based on Table 1. Distributions: Asia = Asia (i.e. China, India etc) (includes one that occurs worldwide); SE Asia = Insular and mainland Southeast Asia; Phil = Throughout Philippines; Visayans = Central islands of the Philippines (incl. Negros, Panay, Cebu, Sibuyan, Bohol, Leyte, Samar, Masbate); N-P = Negros-Panay Faunal Region (incl. Masbate, Ticao, Panay, Guimeras, Negros, Cebu, Siquijor); Negros = Only occurs on this island.

Species code	Species	Habitat	Described by (sp)	Described by (ssp)	Distribution (sp)	Distribution (ssp)
S 1	*Mycalesis georgi georgi*	OF, SF, RF	Aoki & Uemura, 1982	Aoki & Uemura, 1982	Phil	Phil
S 2	*Mycalesis teatus teatus*	OF, SF, RF	Felder, 1863	Fruhstorfer, 1911	Phil	N-P
S 3	*Mycalesis perseus caesonia*	SG	Fabricius, 1775	Wallengren, 1860	Asia	Phil
S 4	*Melanitis leda leda*	OF, SF, RF	Linnaeus, 1758	Linnaeus, 1758	Asia	Asia
S 5	*Melanitis boisduvalia boisduvalia*	OF	Felder, 1863	Felder, 1863	SE Asia (Phil & Indonesia)	Phil
S 6	*Melanitis atrax soloni*	OF, SF, RF	Felder, 1863	Okano, 1991	SE Asia (Phil & Indonesia)	N-P
S 7	*Lethe chandica canlaonensis*	OF, SF, RF	Moore, 1857	Okano, 1991	Asia	N-P
S 8	*Ptychandra leucogyne*	OF, SF, RF	Felder, 1867		Phil	
S 9	*Ypthima stellera stellera*	RF, SG	Eschscholtz, 1821	Eschscholtz, 1821	Phil	Phil
S 10	*Acrophtalmia yamashitai*	OF, SF, RF	Uemura & Yamaguchi, 1982		N-P	
S 11	*Zethera musides*	OF, SF, RF	Semper, 1878		Visayans	
S 12	*Elymnias sansoni sansoni*	RF, SG	Jumalon, 1975	Jumalon, 1975	N-P	N-P
S 13	*Ragadia luzonia negrosensis*	SG	Felder, 1861	Yamaguchi & Aoki, 1982	Phil	Negros
S 14	*Faunis phaon carfinia*	OF, SF, RF	Erichson, 1834	Fruhstorfer, 1911	Phil	N-P
S 15	*Amathusia phidippus negrosensis*	RF	Linnaeus, 1763	Okano, 1986	Asia	N-P
S 16	*Discophora ogina pulchra*	RF	Godart, 1824	Nihira, 1987	Phil	N-P
PI 1	*Eurema hecabe tamiathis*	OF, SF, RF, SG, CU	Linnaeus, 1758	Fruhstorfer, 1910	Asia (China & Phil)	Phil
PI 2	*Catopsilia pomona pomona*	OF, SF, RF	Fabricius, 1775	Fabricius, 1775	Asia	Asia
PI 3	*Appias phoebe montana*	M	Felder, 1861	Rothschild, 1896	Phil	Negros
PI 4	*Cepora boisduvaliana negrosensis*	SF, RF	Felder, 1862	Okano, 1991	Phil	N-P
PI 5	*Delias henningia henningia*	OF, SF, RF, SG	Eschscholtz, 1821	Eschscholtz, 1821	SE Asia (Phil & Borneo)	Phil
PI 6	*Delias hyparete luzonensis*	SF	Linnaeus, 1758	Felder, 1862	Asia	Phil

Species code	Species	Habitat	Described by (sp)	Described by (ssp)	Distribution (sp)	Distribution (ssp)
PA 1	*Menelaides deiphobus rumanzovia*	RF, SG, CU	Linnaeus, 1758	Eschscholtz, 1821	SE Asia	Phil (exc. Palawan)
PA 2	*Menelaides helenus hystaspes*	OF, SF, RF	Druce, 1864	Felder, 1862	Asia	Phil (exc. Palawan)
PA 3	*Troides rhadamantus rhadamantus*	RF	Lucas, 1835		Phil	Phil (exc. Palawan)
PA 4	*Atrophaneura semperi baglantis*	SG, CU	Felder, 1861	Rothschild, 1908	Phil	Negros
PA 5	*Graphium eurypylus gordion*	SG	Linnaeus, 1758	Felder, 1864	SE Asia	Phil (exc Palawan)
PA 6	*Graphium sarpedon sarpedon*	RF, CU	Linnaeus, 1758	Linnaeus, 1758	Asia	
N 1	*Lexias satrapes amlana*	OF, SF, RF	Felder, 1861	Jumalon, 1970	Phil	N-P
N 2	*Tanaecia lupina howarthi*	OF, RF	Jumalon, 1975	Jumalon, 1975	N-P	Negros
N 3	*Charaxes amycus negrosensis*	RF	Felder, 1861	Schroeder & Treadaway, 1982	Phil	Negros
N 4	*Cyrestis maenalis negros*	SF, RF	Erichson, 1831	Martin, 1903	SE Asia	Negros
N 5	*Rhinopalpa polynice panayana*	RF, CU	Cramer, 1779	Fruhstorfer, 1912	SE Asia	N-P
N 6	*Junonia almana almana*	RF, SG	Linaeus, 1758	Linaeus, 1758	Asia	Asia
N 7	*Junonia hedonia ida*	RF, SG	Linaeus, 1758	Cramer, 1775	SE Asia	SE Asia
N 8	*Moduza jumaloni jumaloni*	RF	Schroeder, 1976	Schroeder, 1976	N-P	N-P
N 9	*Hypolimnas anomala anomala*	CU	Wallace, 1869	Wallace, 1869	SE Asia	SE Asia
N 10	*Hypolimnas bolina philippensis*	RF	Linaeus, 1758	Butler, 1874	Asia	SE Asia
D 1	*Euploea mulciber kochi*	OF, RF	Cramer, 1776	Moore, 1883	SE Asia	N-P
D 2	*Ideopsis gaura canlaonii*	OF, SF, RF	Horsfield, 1829	Jumalon, 1971	SE Asia	Negros
D 3	*Parantica luzonensis luzonensis*	RF, SG	Felder, 1863	Felder, 1863	SE Asia	Phil
D 4	*Parantica vitrina oenone*	RF, SG, CU	Felder, 1861	Butler, 1865	Phil	Phil (Visayans & Mindana

Discussion

The NNFR supports a diverse butterfly fauna with most of the species recorded dependent on forest habitat. Most importantly, from a biodiversity conservation perspective, many of these are endemic to the Philippines or more restricted geographic ranges within the Philippines, and 40% of species encountered are listed as uncommon or local in occurrance. The species found exclusively outside the forest habitats were also found to have restricted geographical ranges. Thus, the NNFR appears to represent one of the few remaining refuges on Negros for many forest species that are restricted in their ecological range and thus can only be supported by the remaining similar, but limited, habitat types on Negros.

The Satyridae was the most speciose family. The main food plants of the Satyridae family mean that they can colonize diverse habitats; tropical Satyridae larvae feed mainly on grasses and palms (D'Abrera, 1982, 1985), and this may in part account for the high number of species of this family recorded in this study. In disturbed forest the reduction in the canopy encourages growth of pioneer trees, herbaceous plants, and grasses; however, palms, which are harvested by local communities, are often very rare. In old-growth forest, however, palms are abundant, although the density of the canopy reduces the grasses and herbaceous plants occurring on the canopy floor (Turner, Slade, & Ledesma, 2001; Slade, 2002).

It appears that only one species (*Melanitis boisduvalia boisduvalia*) is in danger of localized extinction if the old-growth forest is lost. This species was absent from the disturbed forest sites, being present only in the old-growth forest. While it is not a Negros endemic, it is endemic to the Philippines, and appears from our study to require undisturbed/old-growth forest for its survival, although in other sites it has been found in disturbed forest areas

(Treadaway, pers. comm.). In agreement with our observations, Treadaway (1995) lists this species as uncommon or only occurring locally. With so little undisturbed forest left in the Philippines, this species could be at risk of global extinction in the years to come.

It could be argued that since 38% of the species were found outside the forest boundaries, they are of less conservation importance. Thus, Slade (2002) proposed that of primary conservation importance is the old-growth forest with its high abundances of restricted-range forest species. However, it should also be noted that most of the species found outside the forest also had restricted geographical ranges, and two of the species occurring only outside the forest habitats were endemic to Negros at the sub-species level. Moreover, one of these species, *Atrophaneura semperi baglantis*, is listed as rare (Treadaway, 1995). Thus, these species must also be of conservation interest.

Several authors have stressed the importance of sub-species endemism, particularly if the goal of conservation is to preserve genetic diversity (Vane-Wright, Humphries, & Williams, 1991; Brooks *et al.*, 1992). Of the sub-species recorded, 84% are endemic to the Philippines, 50% endemic to the Negros-Panay faunal region, and 21% endemic to Negros island alone. These results are similar to those of Slade (2002). The Philippines has already been identified as a 'critical' area for butterfly conservation (Danielson & Treadaway, 2004). Baltazar (1991) found that 44% of the butterflies occurring in the Philippines were endemic, while 45% of the total species and sub-species were endemic. Similarly, Treadaway (1995) concluded that 39.3% of butterflies in the Philippines were endemic. Ackery & Vane-Wright (1984) identified areas that are centers of diversity for butterflies of the family Danaidae, with Mindanao in the southern Philippines listed as the third of 31 critical faunas for Danaidae butterflies. A similar critical fauna analysis by

Collins & Morris (1985) listed the Philippines second among 170 countries for Papilionidae butterflies, with only Indonesia having more endemic species. Similarly, considering only the Papilionidae, the highest Philippine percentage species endemism is found on Mindanao (50%), followed by Luzon (46%), Leyte (44%), Samar (37%), Mindoro (36%), and Negros and Panay (31.6%) (Treadaway, 1995). Thus, NNFR, along with other large, forested areas of the Philippines, should be high on the list of sites to be given priority protection.

Treadaway (1995) records 145 species of butterflies, of the families inventoried for this study, on Negros. Of these, we recorded 42 species during our survey period. While this at first appears to be only a small sub-set of known species, it must be remembered that this inventory was primarily aimed at recording forest species in a small area of sub-montane rainforest. Many butterfly species, such as some species of Nymphalidae and Papilionidae, are sun-loving and ruderal and are primarily found outside forest areas. Moreover, forest species tend to be more habitat specific and thus endemitic (Hamer *et al.*, 1997; Spitzer *et al.*, 1993, 1997), perhaps explaining the higher endemicity values compared to when the butterflies of the Philippines are taken as a whole. Butterflies also respond to elevational gradients (Wolda, 1987; Sparrow *et al.*, 1994), with lower species richness at increased elevations. Other studies in montane rainforests in Vietnam found species richness to be between 23-60, depending on the time of year the study was conducted (Spitzer *et al.*, 1993, 1997).

It is also probable that conspicuous, active species will be more easily observed than cryptic, sedentary ones, perhaps resulting in an under-representation of the latter. It has been suggested that the opening up of the forest in disturbed sites, and the lowering of the canopy may make it easier to observe butterflies and thus increase species richness

and abundance relative to closed canopy, old-growth forest (Willott *et al.*, 2000). This argument is similar to the one that ground-based transect sampling may underrepresent canopy species (Bowman *et al.*, 1990). It is often suggested that the lower canopy levels in disturbed forest allow canopy species to descend to the ground and thus be observed to a greater extent than in undisturbed forest. This may account for the absence of species known to visit the canopy and migrant species (which are often found in the canopy rather than in the understory) from the old-growth forest, while being present in the highly disturbed forest (e.g. *Troides rhadamantus*, *Graphium sarpedon sarpedon*, *Hypolimnas bolina philippensis*). However, evidence for vertical stratification in tropical butterflies is uncertain, and several other canopy visitors and migratory species (e.g. *Catopsilia pomona pomona*, *Menelaides helenus hystaspes*, *Euploea mulciber kochi*) were encountered in the old-growth forest as well as in disturbed sites. This suggests that 'canopy' species were being sampled effectively, and that stratification was perhaps not as important as other factors, such as availability of food plants.

Species accumulation curves plotted by Slade (2002) as part of a study into the effects of forest disturbance on butterflies in the NNFR showed that during a two-month period most species had been accounted for, except in the secondary re-growth forest where the curve had not yet reached a plateau. This study recorded only 29 of the species listed here. The species not found during the study were primarily the non-forest ruderal species, as only forested habitat was sampled. This again points to the lower species richness of sub-montane and montane forests compared to lowland forests and non-forested areas. As stated earlier, this work does not intend to present a definitive list of the butterfly fauna of the NNFR but attempts to outline the first representative inventory, of a specific forest catchment. It

forms part of an on-going research program, including continued inventory work on the butterflies. Further inventory work will now be expanded to include the canopy, lower elevations, and areas outside the forest reserve, as many species that have been recorded on Mt. Canlaon have not yet been recorded in the NNFR (Treadaway, pers.comm.). Surveys will also be expanded to include early morning and late afternoon hours, overcast, but not rainy days, and sunny breaks during rainy days, as some species are known to fly at these times and be easier to catch (Treadaway, pers.comm.). The other method available for butterfly surveys is trapping using baits. This method only samples the guild of fruit-feeding butterflies, and not all the species in the habitat (Daily & Ehrlich, 1998; Wood & Gillman, 1998). Several authors have suggested that baited traps can, however, provide complementary data to visual censuses (Sparrow *et al.*, 1995; C.G. Treadaway, pers. comm). Pilot trials during the study period using traps, baited with both fruit and carnivore dung, did not result in any new species not encountered during visual censuses. However, it is accepted that species attracted to traps can change with season and further surveys will expand the trapping regime to include more traps at varied heights from the ground.

Conclusion

This study has found that the Upper Imbang-Caliban Watershed of the NNFR is similar to many forested areas in the Philippines, as it has a butterfly fauna that is species rich and exceptionally endemic, both at the species and sub-species level. If this holds true for the rest of the NNFR, then, as one of the last tracts of forest left on Negros, it is clearly in need of protection. A continuation of this inventory and further studies in other areas of the NNFR is necessary to draw firm conclusions and recommendations. However, this study confirms that of Slade (2002) that the preservation

of the remaining forest areas of the NNFR, and in particular any tracts of undisturbed or old-growth forest, is of primary importance for conservation if populations of restricted-range forest butterflies are to be preserved. Further loss of this could eventually lead to the localized elimination of some species. It is hoped that this inventory and the resulting field guide will assist much-needed butterfly research within the NNFR in the future. Danielsen & Treadaway (2004) have just published a list of priority conservation areas for Philippine butterflies, listing Mt. Canlaon National Park on Negros as one of the irreplaceable conservation areas. It is suggested that the NNFR could provide a second conservation area for many of the butterfly species found in the Mount Canlaon National Park.

Sustainable management, by definition, means that the Reserve will not be an area set aside only for conservation but will probably eventually have a degree of sustainable extraction of certain monitored timber and non-timber forest products, as well as ecotourism, and human habitation (Turner, Slade, & Ledesma, 2001). The results of this study suggest that protection of the remaining areas of old-growth and undisturbed forest is paramount. However, while undisturbed forest is important for some butterfly species, disturbed forest may also be important for sun-loving butterflies (Sparrow *et al.*, 1994; Wood & Gillman, 1998). Moreover, it has also been suggested that butterflies could play a key role in the sustainable management of the NNFR through butterfly farming and ecotourism initiatives (see Slade, 2002).

Although previous studies have already highlighted the clear conservation importance of the NNFR for other taxa (Hamann *et al.*, 1996, unpublished; Turner, Slade, and Ledesma, 2001; Turner, Slade, & Hesse, 2002, unpublished), the Reserve is yet to receive legal protection. Turner, Slade, & Hesse (2002, unpublished) suggest that while actual timber

extraction is now minimal due to most valuable species having already been removed, unmonitored non-timber extraction of bamboo and rattan still exists, while settlement and localized clearance of lower forest areas by *kaingin* (slash and burn agriculture) continue to eat into the forest. Moreover, the hunting of birds and, to a lesser extent, mammals both for food and for trade, is still prevalent (Hamann *et al.*, 1996, unpublished). Legal protection under the National Integrated Protected Areas System (NIPAS) has already been suggested based on data collected on birds in the area (Collar *et al.*, 1999; Turner, Slade, & Hesse, 2002, unpublished). This study reinforces this recommendation, based on the high endemicity of butterfly species found in the Reserve.

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